# Assessing the effect of integrated water resources management on the quality of water in the Pra Basin Ghana

# Summary

The findings in this study assess the effectiveness of Integrated Water Resources Management (IWRM) in the Pra Basin of Ghana by looking at the implementation process and how it has impacted on the quality of the water resources. Using the implementation to assess the effectiveness of IWRM will help trace the root cause of any weakness identified, in other to propose appropriate measures to address them and improve on the management system.

Water resources management from the global level to the local level has undergone a series of historical transformations with the aim of getting an effective water management system (Hassan, 2011). Unfortunately, the earlier management reforms were said to be un-integrated and insensitive to the ecosystem and the environment (Merrey, 2008). The system is said to be fragmented with conflicting roles among stakeholders resulting in challenges in the management system. The Rio conference on the environment recommended that water should now be managed in an integrated manner. The integrated approach is projected to address the gaps in the un-integrated and achieve an effective water management system. Full and practical implementation of IWRM is very important to ensure effective water resources management. However, IWRM is criticized on the basis that it is not fully implemented and therefore the benefits are not realized. Ghana has been implementing IWRM since 2011 in the Pra Basin. The main aim of this study is to examine the gaps in the process of implementation and how it has impacted on the water quality in order to propose interventions that can help improve future implementation process and ensure effective water resources management.

**Chapter 2** examines the effectiveness of Water Resources Management in the Pra Basin by assessing how it has been implemented to address the needs by addressing the following questions: 1) is the IWRM the appropriate management option? 2) Does the Pra Basin framework conform to the proposed IWRM framework? 3) What is working well? 4) What is not working well? 5) What is not happening but should have? The IWRM implementation in the Pra Basin on paper conforms to the proposed framework however, they are far apart in practice. Generally, the creation of the enabling environment, the institutional framework, the management instrument, and the problem identification in the basin was well conducted. However, there are questions when it comes to the appropriateness of the IWRM for the Pra Basin. The questions center on 1) the translation of framework on paper into practice; 2) some major stakeholders still not operating at the district level; 3) staff strength and logistical constraints; 4) absence of timelines in all the actions; 5) opinion leaders not seeing themselves as part of the board though they are represented; 6) 'how' the plan of actions will be achieved. Regarding what is not happening but should have, although Illegal mining (Galamsey) is very prevalent in the basin; the management framework is silent on it. The current framework needs improvement in the areas where questions have been raised if it needs to function well. To assess the effectiveness of the IWRM framework we assess the quality of

the water resources from different dimensions.

**Chapter 3** assesses the quality of the water resources after the implementation of the IWRM framework using water quality index (WQI). Eight (8) water sampling points from upstream to the downstream of the Basin were selected for sampling. Eight (8) physico–chemical and microbial parameters were used for the water quality measurement. Those sampling sites were chosen because the baseline data were measured using samples from those sites. The result generally shows significant deterioration in the quality of the water resources after the implementation, of IWRM. The level of suspended solids in the water was found to be a major contributor to the observed water quality deterioration. The high levels of suspended particles are due to illegal mining activities in and around the rivers. The worrying situation was that all the study sites failed to maintain their baseline water quality indexes. The study recommended the assessment of heavy metals in the water in addition to the parameters already assessed due to the illegal mining activities going on in the basin.

**Chapter 4:** assesses the levels of heavy metals from upstream to the downstream of the Pra Basin Rivers. The heavy metal assessment was based on two indices, the Canadian Council of Ministers of the Environment (CCME) Water Quality Index (WQI) and Nemerow's Pollution Index (NPI). The metal contamination measurement is very necessary because these rivers aside serving as the raw water sources for drinking water treatment plants in the basin is also used by some inhabitants along these rivers for domestic activities under water stress conditions. In all nine (9) metals were assessed and out of these five (5) metals exceeded the safe drinking water guidelines making the water unsafe for domestic activities like cooking. The pollution index reveals six metals namely Pb, Cd, Cr, Ni, Fe, Zn as the principal metal pollutants in both the dry and wet seasons whereas Mn, As, and Cu, were found not to contribute to the pollution effect. The water quality index confirms that the water quality is marginal to fair in the dry season and poor for 26 out of the 27 sites in the wet season. Generally, the studied rivers (Pra, Offin, and Oda) are polluted which is a serious threat to the health of inhabitants in the villages which still use the water for cooking activities.

**Chapter 5:** assesses the levels of heavy metals in the sediments of the Pra Basin Rivers from the upstream to the downstream for dry and wet seasons. River sediments have the potential of serving as sinks for heavy metals at high pH and releasing them into the water again under low pH or during scouring. Knowing the pollution status gives the overall picture of the pollution status of the water. In addition, certain benthic fishes feed on the sediments so may serve as a possible route into the food chain. In all 8 metals namely arsenic (As), lead (Pb), cadmium (Cd), zinc (Zn), manganese (Mn), total chromium (Cr), nickel (Ni) and iron (Fe) were studied from 27 sampling sites. The result reveals enrichment at all site for the metals Cr, Pb, and Cd in the

wet seasons. However, only 4 out of the 27 sites showed Ni enrichment in the wet season. Contrary to the wet season, only Pb and Cr recorded enrichment at all sites during the dry season. Fifteen (15) out of the 27 sites recorded Cd enrichment and 24 out of the 27 sites recorded Ni enriched during the dry season. For both dry and wet seasons, the pollution load index for all the sites except one was at the background levels which is a sign of non-deterioration of the sites studied. In the wet season, the calculated Igeo reveals that the study area is not contaminated with respect to As, Zn, Fe, and Mn; uncontaminated to moderately contaminated with Cd; moderately contaminated with Cr; uncontaminated to moderately to heavily contaminated with Ni, and moderately to heavily contaminated with Pb. The dry season Igeo results reveal non-contamination of the study area with respect to As, Fe, and Mn; uncontaminated to moderately contamination with Zn; moderately contaminated with Cr; uncontaminated to heavily contaminated with Cd; uncontaminated to extremely contaminated with Ni; and moderately to extremely contaminated with Pb. The high levels of Cd, Pb, and Cr in all the sites are due to unregulated illegal mining activities occurring in and around the study area. It is hoped that this study will prompt the basin management board to improve their management strategies in controlling unregulated illegal mining in the basin.

**Chapter 6:** reports on a behavioral study using the Theory of Planned Behavior (TPB) to assess the behavioral factors which influence illegal miner's choice of an alternative job. This study was motivated by the fact that effort by the government to stop illegal mining failed despite the provision of an alternative job. The findings from the structural equation analysis revealed that the model could predict illegal miner's intention of choosing an alternative job. The attitude was found to be the only dominant significant antecedent of the behavioral intention. The findings from the study reveal that Perceived Behavioral Control (PBC) which has been the focus of the job intervention in the basin is not a predictor of intention which confirms why miners are back to site working.

**Chapter 7:** summarizes the main findings from the various studies, methodologies involved and the implications of this study on future research. From the main findings of this study, it can be concluded that there are gaps in the implementation process which have negatively affected the effectiveness of water resources management in the basin. First, our research highlights six implementation challenges which impact negatively on the integrated water resources management. Second, these implementation gaps are found to cause the pollution of the water resources by introducing a high level of suspended particles and heavy metals making the water unsafe for those who still depend on them under water stress conditions. Third, the river sediments which is known to serve as sinks for heavy metals was found to be enriched and contaminated with heavy metals. Fourth, an effort to improve the water management through the provision of an alternative job to reduce failed because the control belief which was used as the focus of the intervention was not

a predictor of the behavioral intervention. The water management system can be effective if it is fully implemented and monitored with the measurable determinants and taking appropriate action on the feedback from these determinants.